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(54) APPARATUS FOR REPAIRING CARTILAGE

VORRICHTUNG ZUR REPARATUR VON KNORPELGEWEBE

DISPOSITIF POUR LA REPARATION DE CARTILAGE

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Description

[0001] This invention relates to repairing cartilage, for example, articular cartilage on the femur.

[0002] The document EP-A-0 307 241 discloses an apparatus comprising all the features defined in the preamble of claim 1.

[0003] Articular cartilage that is damaged (e.g., torn or excessively worn) may be repaired in a variety of ways. For example, the damaged cartilage may be shaved or scraped from the bone surface, thereby causing bleeding which stimulates the growth of fibrocartilage. Small holes may be drilled in the bone to promote bleeding and fibrocartilage growth. Alternatively, an allograft (e.g., cartilage grown *in vitro* from cartilage tissue removed from the patient) may be implanted by attaching a periosteum membrane (harvested, e.g., from the patient's tibia) to the bone surface and injecting the allograft beneath the membrane. The periosteum provides a healthy environment which promotes further cartilage cell growth.

[0004] One general aspect of the invention is directed to apparatus for use with a surgical instrument during a procedure in which a tissue graft is inserted into bone tissue, comprising

a guide (12) configured to orient the surgical instrument perpendicularly to a surface of the bone tissue, said guide (12) including a tubular guiding portion (13) disposed along a longitudinal axis for engaging the surgical instrument and a tissue-engaging portion (14) oriented perpendicularly to said longitudinal axis at a distal end (17) of the tubular guiding portion (13) characterised in that the tissue engaging portion (14) comprises a step-like decrease in diameter of the tubular guiding portion (13) to form a rim (14a) the tubular guiding portion of reduced diameter defining a flange (16) projecting distally from the rim (14a).

[0005] Generally, the apparatus of the invention will include the surgical instrument and preferred embodiments may include one or more of the following features.

[0006] The surgical instruments used with the guide include a drill for drilling a hole for receiving the tissue graft, a dilator having a distal end sized to enlarge the hole, and an insertion tool for inserting the tissue graft into the hole. The guiding portion of the guide is sized to receive each instrument and orient it substantially perpendicularly to the bone surface. Preferably, the tissue graft includes bone with a layer of cartilage thereon.

[0007] Preferably, the drill includes a distal end that comprises a pointed distal tip and a plurality of cutting flutes circumferentially spaced around the distal end proximally adjacent to the tip. The drill preferably includes markings to indicate a depth of the hole. The distal end of the dilator is preferably tapered, and the dilator includes markings to indicate the depth that the distal end is inserted in the hole.

[0008] The portion of the insertion tool engaged by the guide has an adjustable length relative to the length of the guide so that the amount by which the graft protrudes from the hole can be correspondingly adjusted. The length-adjustable portion of the insertion tool includes a rod attached to a handle configured to engage a proximal end of the guide. The distal end of the rod is configured to engage the graft, and the proximal end of the rod is progressively insertable into an opening in the handle to adjust the length of the rod.

[0009] For example, the proximal end of the rod is threadably received within the opening so that relative rotation between the handle and the rod adjusts the length of the rod. A resilient member disposed in the opening engages the proximal end of the rod to maintain the rod in position at the adjusted length. The rod includes markings to indicate the amount by which the graft protrudes from the hole.

[0010] The guide may have a wide variety of suitable configurations. The guide comprises a tube having a passage disposed along the longitudinal axis to provide the guiding portion. The tissue-engaging portion is disposed at a distal end of the tube and is, for example, a rim of the tube. In some embodiments, the tissue-engaging portion also includes an annular flange that projects distally from the rim and is configured to be seated within the bone tissue. In other embodiments, the tissue-engaging portion comprises an enlarged lip disposed circumferentially around the distal end of the tube. A portion of the lip may include a recess therein.

[0011] The guide may also include a spacer for positioning the guiding portion at a selected location relative to a feature on the bone tissue. For example, the feature is a hole in the bone tissue. In this case, the spacer includes a member (e.g., a pin or a tooth) that projects distally from the tissue-engaging portion of the guide for insertion into the hole. The member may be retractable with respect to the tissue-engaging portion, or not. The member may be disposed on a sleeve that is insertable over the guide. If the feature includes a region of cartilage on the bone tissue, the spacer may include an enlarged lip disposed adjacent to the tissue-engaging portion of the guide for engaging the region of cartilage.

[0012] In some embodiments, the guide includes a window for allowing viewing of the passage. The guide may include a valve for blocking fluid flow through the passage. In other embodiments, a portion of the guide comprises clear material.

[0013] Another aspect of the invention features a set of instruments that includes the guide, the drill, and the insertion tool.

[0014] In preferred embodiments, these instruments are sized to insert a tissue graft having a selected size. At least one other set of such instruments may be provided and sized to insert tissue grafts of a different size.

[0015] The set of instruments may also include the dilator and a template for measuring a size of the tissue graft.

[0016] In addition, the set may include a tool for removing the tissue graft from a bone. The tool includes

a chisel having a hollow shaft that extends distally from a handle and terminates in a sharpened, hollow tip configured to capture the tissue graft therein, the handle having a passage therein that communicates with the hollow shaft. A collar is slidable over the shaft to shield the hollow tip during removal of the tissue graft therefrom, and a member is insertable into the hollow tip to engage the tissue graft and remove the tissue graft proximally through the shaft and the passage of the handle. The collar includes a flared opening disposed adjacent to the tip when the collar is inserted over the shaft. The member applies force to the bone portion of the graft -- rather than the cartilage on the upper surface of the graft -- during removal, thereby reducing the risk of damaging the cartilage.

[0017] The set of instruments may also be equipped with a device for determining an entry portal for the guide over the bone surface. The device includes a needle disposed along a longitudinal axis and having an open distal end, and a plurality of prongs disposed within said needle and having resiliently curved distal tips. The prongs are slidable within the needle between a retracted position in which the distal tips are disposed within the needle and an extended position in which the distal tips project from the needle to engage the bone surface and define a plane that is perpendicular to the longitudinal axis. The device is small and can be inserted into the body even multiple times to determine the correct (e.g., perpendicular) entry portal location with a minimum of patient trauma.

[0018] Among other advantages, the invention provides an efficient and accurate way of repairing cartilage that may be performed arthroscopically, thereby reducing trauma and minimizing healing time. The guide allows the graft-receiving holes to be formed perpendicularly to the bone surface and the graft to be inserted straight into the hole, despite the curved nature of the bone. This greatly enhances the match between the grafted cartilage and the contour of the surrounding cartilage. In addition, because the height of the graft (i.e., the amount that the graft protrudes from the hole) is adjustable, the grafted cartilage can be easily positioned at the same height as the surrounding cartilage. This provides a high quality repair and reduces the risk that further surgery will be needed to sculpt the grafted cartilage to the height and contour of the surrounding, existing cartilage.

[0019] In addition, the various configurations of the guide allow the graft receiving holes to be marked and closely positioned with respect to each other while maintaining sufficient bone wall thickness to promote healing and a healthy environment for the grafts. The accessories provided with the chisel (e.g., the collar and graft-removal member) greatly facilitate withdrawal of the graft from the chisel without injuring the surgeon (with the sharp chisel tip) or damaging the graft (with the graft-removal member). The entry portal positioning device allows the surgeon to determine the correct (e.g., perpendicular) entry portal location with a minimum of patient trauma.

[0020] Other features and advantages of the invention will become apparent from the following detailed description, and from the claims.

Fig. 1 shows a femur with an area of damaged articular cartilage.

Figs. 2a-2f show a set of surgical instruments for repairing the area of damaged articular cartilage.

Figs. 3-9 show the use of the instruments shown in Figs. 2a-2f in repairing the area of damaged articular cartilage.

Figs. 10a and 10b show an example of a guide not representing the invention.

Figs. 11a-11c show the guide of Figs. 2a and 2b with a spacer.

Figs. 12a and 12b show the use of the guide of Figs. 2a and 2b with a retractable spacer.

Figs. 13a and 13b show another guide for locating perpendicularity with respect to a tissue surface.

Figs. 14a and 14b show the use of the guide of Figs. 13a and 13b in locating perpendicularity with respect to a tissue surface.

[0021] Fig. 1 features a method for replacing damaged or defective cartilage, e.g., articular cartilage 4 on a patient's femur 1. The invention provides a set of surgical instruments (described below) for performing the procedure efficiently and accurately.

[0022] Articular cartilage 4 covers femoral condyles 2 and 3 and protects them from wear and mechanical shock. Consequently, an area 5 of articular cartilage 4 may become damaged (e.g., torn or excessively worn). The damaged area 5 is repaired by removing the damaged articular cartilage 4 and implanting healthy cartilage harvested from another area of femur 1, such as the ipsilateral side of the nonarticular condylar surface 6 or the intercondylar notch 7.

[0023] Figs. 2a-2f show a set of surgical instruments for repairing damaged area 5 of articular cartilage. The surgical instruments include a guide 12 (Figs 2a, 2b), a chisel 20 (Fig. 2c), and a series of instruments -- a drill 40 (Fig. 2d), a dilator 47 (Fig. 2e), and an insertion tool 50 (Fig. 2f) -- that are used with guide 12 during the procedure. The instruments and the procedure are described in detail below, but briefly, chisel 20 is used to cut a cylindrical bone and cartilage graft from, e.g., the ipsilateral side of the nonarticular condylar surface 6 or the intercondylar notch 7. After the damaged cartilage 4 has been removed in damaged area 5 to expose the condylar bone surface, drill 40 is inserted through guide 12 to drill a hole in the bone that will receive the graft, and dilator 47 is inserted through guide 12 to slightly and temporarily enlarge the hole to accommodate the graft. Finally, the graft is implanted into the hole with insertion tool 50. This procedure is repeated until an array of bone and cartilage grafts have been implanted to fill damaged

area 5 with replacement cartilage.

[0024] To ensure that the grafted cartilage follows the contour of surrounding cartilage 4, the bone and cartilage grafts must be formed perpendicularly or substantially perpendiculary to the bone surface, and the graft-receiving holes must also be drilled & substantially perpendicularly to the bone surface. In addition, grafts must be inserted to the proper depth so that the grafted cartilage neither protrudes nor is recessed from the surrounding cartilage. The instruments and surgical technique provided by the present invention achieves these goals.

[0025] Guide 12 is the device that ensures the perpendicular formation of the graft-receiving holes. Guide 12 includes a hollow tube 13 with an interior passage 19 that extends between open distal and proximal ends 17, 18. Guide 12 is elongated along a longitudinal axis **A**, and a rim 14a at distal end 17 of tube 13 (Fig. 2b) defines a tissue-engaging portion 14 in a plane **A'** oriented perpendicularly to axis **A**. As shown in Fig. 2a, the outer diameter of tube 13 decreases in a step-like manner to form rim 14a and then gradually decreases to form flange 16. Rim 14a has a width of 0.5 mm, and flange 16 has a length of 3 mm from rim 14a to a distal end of flange 16. In addition, the edge of flange 16 is slightly chamfered. Accordingly, when guide 12 is positioned on the bone surface (such as a curved surface on femur 1) so that flange 16 is seated in the bone and rim 14a contacts and is flush with the bone completely around its circumference, axis **A** is perpendicular to the bone surface. By being seated in the bone, flange 16 helps to hold the perpendicular position of guide 12. Thus, an instrument (e.g., chisel 20 drill 40, dilator 47, or insertion tool 50) inserted through guide passage 19 is aligned perpendicularly to the bone surface.

[0026] Passage 19 is sized and shaped to receive drill 40, dilator 47, and insertion tool 50, which in turn are dimensioned according to the desired diameter of the graft (e.g., 2.7 mm, 3.5 mm, 4.5 mm, 6.5 mm or 8.5 mm). Alternatively stated, a complete set of instruments that includes a guide 12, a drill 40, a dilator 47, and an insertion tool 50 (as well as a chisel 20) is provided for each size graft desired to be inserted into defect area 5.

[0027] Guide 12 also includes a handle 15 located near proximal end 18. Handle 15 has a larger outer diameter than the remainder of guide 12 and includes a series of flat, faceted surfaces 15a arranged around the circumference of guide 12 for ease of gripping. The diameter of passage 19 is constant over the length of guide 12. As a result, handle 15 provides a thickened rim 15b surrounding open proximal end 18 to withstand the impact of instruments (such as insertion tool 50) during use, as will be described below. A window 19a formed in the walls of tube 13 near distal end 17 is open to passage 19. Window 19a allows the surgeon to see into passage 19 during use to, e.g, visualize the position of the graft.

[0028] Guide 12, tissue-engaging portion 14, and handle 15 are made from metal and may be integrally formed (e.g., by casting) as a single piece of material. Alternatively, guide 12, tissue-engaging portion 14, and handle 15 may be made from molded or extruded plastic. As discussed above, guide 12 is available in various sizes depending on the size of the surgical instrument to be inserted through guide 12.

[0029] Chisel 20 (shown in Fig. 2c with auxiliary components 30, 32 that are described below) includes an axially elongated, hollow metal shaft 21 that extends distally from a handle 28 to a distal end 24 that terminates in a sharpened, open chisel tip 22. The interior of chisel tip 22 tapers inwardly at 22a to grasp the sides of the graft removed from femur 1. Chisel 20 is available in various sizes depending on the desired size (e.g., diameter) of the graft. For example, chisel 20 may be sized to cut a bone graft having a diameter of 2.7 mm, 3.5 mm, 4.5 mm, 6.5 mm or 8.5 mm. Chisel 20 is described in German Patent No. DE 19503504 A1 and Hungarian Patent No. HU 9402663 A0.

[0030] Handle 28 includes an axial passage that communicates with the interior of shaft 21 and is open at the proximal end of handle 28 for purposes to be described. A transverse hole 26 formed through handle 28 near its proximal end receives the shaft 31 of a tamp 32 during use. That is, tamp 32 is inserted transversely through handle 28 to provide the surgeon with increased leverage when chiseling a graft (see Fig. 4). Tamp 32 serves the additional purpose of removing the graft from chisel 20. A chisel guard 30 is also provided and is insertable over shaft 21 to help avoid injury from chisel tip 22 while the graft is being removed. Chisel guard 30 is a hollow cylinder that includes an enlarged head 33 with a flared opening 33a positioned adjacent to chisel tip 22 when guard 30 is inserted over shaft 21. Flared opening 33a allows the surgeon to insert tamp 32 easily into chisel tip 22. Chisel guard 30 is approximately as long as chisel shaft 21 and is available in various sizes depending on the size of chisel 20.

[0031] To remove the graft from chisel 20, chisel guard 30 is inserted over shaft 21 so that it abuts handle 28. With chisel tip 22 shielded by guard 30, the surgeon inserts tamp shaft 31 into chisel tip 22 to engage the underside of the bone graft, and pushes the graft proximally from tip 22 and out of handle 28. As a result, the force applied to remove the graft from chisel 20 is applied to the bone portion of the graft, rather than to the cartilage on the upper surface of the graft. This helps reduce the risk of tearing or otherwise damaging the grafted cartilage.

[0032] Drill 40 (Fig. 2d) includes an axially elongated metal shaft 41 that fits through guide passage 19 and terminates in a drill bit 42 at distal end 44. Drill shaft 41 has graduated markings 41a, 41b near its proximal and distal ends so that the surgeon can see the position of drill 40 when inserted through guide 12. For example, the surgeon can see distal markings 41b through window 19a of guide 12. Drill bit 42 includes a pointed distal

tip 43a and a plurality of cutting flutes 43b circumferentially spaced around drill bit 42 proximally adjacent to tip 43a. The pointed nature of tip 43a helps prevent drill bit 42 from "walking" on the bone surface so that the graft-receiving holes can be positioned more accurately. Drill 40 is available in various sizes depending on the size of the bone graft. For example, drill 40 may be sized to cut a hole having a diameter slightly smaller than 2.7 mm, 3.5 mm, 4.5 mm, 6.5 mm or 8.5 mm.

[0033] Dilator 47 (Fig. 2e) is used to slightly enlarge the hole formed by drill 40, e.g., by about 0.2 mm, to accommodate the graft cut by chisel 20. Dilator 47 is a solid metal rod 46 that is axially elongated between proximal and distal ends 49a, 49b. The diameter at distal end 49b corresponds to the diameter of drill 40 with which dilator 47 is used. The edge of distal end 49b is slightly chamfered (not shown) to allow dilator 47 to be easily inserted into the hole. Moving proximally from distal end 49b, the diameter of dilator 47 gradually increases by 0.2 mm over a distance **D** of 15 mm (e.g., to a final diameter of 4.7 mm from a distal end diameter of 4.5 mm). Rod 46 has graduated markings 46a, 46b near its proximal and distal ends, so that the surgeon can see the position of dilator 47 when inserted through guide 12. A transverse hole 48 is provided near proximal end 49a and is sized to receive a tamp 32 (Fig. 2c) to form a "T" shaped assembly that provides the surgeon with increased leverage when using dilator 47 to enlarge the graft-receiving hole.

[0034] Insertion tool 50 (Fig. 2f) includes an axially elongated cylindrical metal rod 60 the proximal end 62 of which is received within a chamber 72 in a handle 70 to allow the length **L** of rod 60 that protrudes from the distal end 71 of handle 70 to be adjusted. The proximal end 73 of handle 70 has an enlarged shape to enable the surgeon to securely grasp handle 70 while adjusting length **L**.

[0035] Rod 60 is sized to fit within guide passage 19 and has a flat distal end 64 oriented perpendicularly to rod axis **B**. The proximal portion 62 of rod 60 has a threaded portion 66 which corresponds with a threaded portion 74 of handle 70. Calibration markings 69 are disposed on rod 60 distal of proximal portion 62. Markings 69 are spaced 1 mm apart and may be designated by numerals (0, 1, 2, etc.).

[0036] The configuration of chamber 72 is substantially complementary to that of the portion of rod 60 that fits within handle 70. That is, chamber 72 includes a threaded portion 74 which receives threaded portion 66 of rod 60. An O-ring 76 is disposed in a groove 75 formed around the exterior of chamber 72 slightly proximally of handle end 71.

[0037] The surgeon adjusts the length **L** of rod 60 by rotating rod 60 with respect to handle 70 (e.g., by twisting rod 60 further into handle 70) while observing calibration markings 69. The friction between O-ring 76 and rod 60 helps to hold rod 60 in place within handle 70 at the position set by the surgeon. Markings 69 indicate the length of rod 60 protruding from handle 70, and more specifically identify the spacing between rod distal end 64 and tissue-engaging portion 14 of guide 12 (Fig. 2a). For example, when marking 69 designated by numeral 0 is aligned with handle distal end 71, the length **L** of rod 60 equals that of guide 12 to rim 14a, and as a result rod distal end 64 is flush with rim 14a when insertion tool 50 is fully inserted into guide 12 (with distal end 71 of handle 70 abutting guide proximal end 18).

[0038] Inserting rod 60 farther into handle 70 causes rod distal end 64 to be recessed from rim 14a by a distance that corresponds to the calibration marking 69 (e.g., 1 mm, 2 mm, 3 mm, etc.) that is aligned with handle distal end 71. For example, when length **L** of rod 60 is set at the marking designated by the numeral 3, distal end 64 of rod 60 is recessed by 3 mm from rim 14a of guide 12. This enables the surgeon to insert the graft at a precise depth in the graft receiving hole so that the cartilage on the graft protrudes from the hole by an amount that corresponds to the height of the surrounding cartilage 4 (Fig. 1).

[0039] As discussed above with respect to Fig. 1, damaged articular cartilage 4 from area 5 is repaired by removing damaged cartilage 4 and implanting grafts with healthy cartilage harvested from elsewhere on femur 1. The use of the instruments shown in Figs. 2a-2f in the grafting procedure will now be described with reference to Figs. 3-9.

[0040] Referring to Fig. 3, the first step is to remove cartilage in damaged area 5 and immediately surrounding areas to create an area 80 of exposed bone surface. The depth **H** of exposed area 80 is measured to determine the thickness of articular cartilage 4 surrounding exposed area 80. Guide 12 is used to determine the optimal number and size of grafts to be implanted into exposed area 80. As shown in Fig. 3, this is done by using guide 12 (Figs. 2a, 2b) to mark hole locations 81 in exposed area 80. When guide 12 is tapped into exposed area 80, rim 14a of guide 12 forms hole location 81 by leaving an annular impression (defined by flange 16 and the exterior edge of rim 14a) in exposed area 80. The holes should be located close together so that a tightly-packed matrix of healthy grafted cartilage can be implanted to cover area 80 as completely as possible. But a sufficient wall thickness (e.g., 1 mm) should be maintained between adjacent holes to provide a stable and healthy environment for the implanted grafts. Rim 14a of guide 12 helps to maintain sufficient wall thickness between holes. As discussed above, rim 14a has a width of 0.5 mm. Thus, when guide 12 is used to mark hole locations 81, adjacent hole locations 81 have a wall thickness of at least 1 mm.

[0041] Referring to Fig. 4, after marking hole locations 81 in exposed area 80, healthy cartilage is harvested from a donor site 82 located, e.g., at the ipsilateral side of the nonarticular condylar surface 6 of femur 1 using chisel 20 (Fig. 2c). Chisel 20 is inserted into the patient's body so that chisel tip 22 engages the surface of donor

site 82. The surgeon gently rocks chisel 20 back and forth on the surface of cartilage 4 until he feels that chisel tip 22 is flush with the surface. With chisel tip 22 in this orientation, chisel shaft 21 is perpendicular to the cartilage surface at donor site 82.

[0042] With chisel 20 aligned perpendicularly to the surface of donor site 82, the surgeon taps or pounds chisel handle 28 with a hammer (not shown) to drive chisel tip 22 into the bone beneath donor site 82 to a depth of 15 mm - 20 mm. After chisel 20 is fully seated, the surgeon inserts tamp 32 through hole 26 of chisel handle 28 to form a "T" shaped tool, which the surgeon moves back and forth until the graft breaks away from the underlying bone. Chisel 20 is then pulled straight up and out of the patient's body. The tapered interior 22a of chisel tip 22 holds the graft within tip 22 as the instrument is withdrawn.

[0043] Referring also to Fig. 5a, graft 87 is primarily bone tissue the proximal end of which is covered by a layer of hyaline cartilage 86. Graft 87 is removed from chisel 20 by sliding chisel guard 30 over chisel tip 22, inserting tamp 32 into chisel distal end 24, and pushing against the bony distal end of graft 87 to slide graft 87 through chisel shaft 21 and out of the proximal end of handle 28. Removing graft 87 in this manner avoids the need to push against hyaline cartilage 86 (i.e., as would be done by inserting tamp 32 into handle 28 rather than into tip 22), thereby reducing the risk of damaging hyaline cartilage 86. This is particularly important because graft 87 often is tightly wedged within tip 22 due to the large forces applied during chiseling. After graft 87 is removed from chisel 20, graft 87 may be cut to the desired length (e.g. 15 mm).

[0044] Referring also to Fig. 5b, a measuring template 85 may be used to determine the length and outer diameter of harvested bone graft 87. The desired size of graft 87 will vary depending on the condition of the harvested graft 87 (e.g., cracks or chips in the graft) and the age of the patient. The size of bone graft 87 as indicated by template 85 will provide an indication to the surgeon as to how much (if at all) a graft-receiving hole should be temporarily enlarged with dilator 47. After harvesting a preselected number of grafts 87 from donor site 82 (or other donor sites on femur 1 or elsewhere), the incisions made over donor site 82 are closed and sutured. Alternatively, grafts 87 can be removed from donor site 82 and implanted in exposed area 80 one at a time.

[0045] Referring to Fig. 6, the first step in the graft implantation portion of the procedure is to insert guide 12 into the patient's body so that rim 14a is centered over one of hole locations 81 in exposed area 80. The surgeon seats flange 16 into the bone and rocks guide 12 back and forth until he feels that rim 14a is flush against exposed area 80, thereby indicating to the surgeon that passage 19 is aligned perpendicularly to the curved bone surface at hole location 81. While holding guide 12 firmly in the perpendicular orientation, the surgeon inserts drill 40 through guide 12 and drills a graft-receiving hole 88 in area 80. Because of the alignment provided by guide 12, hole 88 is formed perpendicularly to the bone surface. By observing markings 41a near proximal end of drill 40 outside the patient's body and markings 41b near distal end of drill 40 through window 19a, the surgeon can limit the depth of hole 88 to, e.g., 15 mm. Drill 40 is then removed from guide 12 and the patient, but the position of guide 12 is maintained.

[0046] As shown in Fig. 7, dilator 47 is inserted through guide 12 and into hole 88 to slightly (e.g., by 0.2 mm) and temporarily enlarge hole 88 so that it will more readily receive graft 87. (Hole 88 relaxes to its original size shortly after graft 87 is inserted to securely grip graft 87 for proper healing.) This operation is facilitated by inserting tamp 32 through hole 48 near the proximal end of dilator 47 to form a "T" shaped tool that is used in much the same way as described above for chisel 20. Dilator 47 is then removed, but again, guide 12 is left in place over hole 88.

[0047] Referring to Fig. 8, graft 87 is inserted into proximal end 18 of guide 12 with layer of hyaline cartilage 86 facing proximal end 18. The surgeon then adjusts length L of rod 60 (Fig. 2f) based on the measured depth H of exposed area 80 to set the height at which cartilage layer 86 will protrude from the bone surface. For example, if exposed area 80 has a depth H of 2 mm, then length L is adjusted to align calibration mark "2" with handle distal end 71, thereby providing a 2 mm recess between rod distal end 64 and rim 14a of guide 12 when insertion tool 50 is fully inserted into guide 12.

[0048] As shown in Fig. 9, graft 87 is implanted at the desired depth in hole 88 by advancing insertion tool 50 into guide 12 until distal end 71 of handle 70 abuts proximal end 18 of guide 12. Thus, rod 60 pushes graft 87 out of distal end 17 of guide 12 and positions graft 87 at the desired depth in hole 88 such that the layer of hyaline cartilage 86 on graft 87 is flush with the layer of articular cartilage 4 surrounding exposed area 80. This process is repeated until all the harvested grafts 87 are implanted into exposed area 80.

[0049] As exposed area 80 becomes filled with implanted grafts 87, it may be necessary to adjust the length L of insertion tool rod 60 so that the later-inserted grafts are implanted to the proper depth. For example, if rim 14a of guide 12 rests on implanted grafts 87 rather than exposed bone in area 80, rod length L must be increased to reduce the recess between rod distal end 64 and rim 14a of guide 12.

[0050] The guide may be a solid member with an exterior channel for receiving the drill, insertion tool, etc. Alternatively, the guide may include a post to which a series of axially spaced, aligned rings are attached for receiving the other instruments.

[0051] Referring to Figs. 10a and 10b, guide 90 has a tissue-engaging portion in the form of an enlarged lip 89 that defines a plane A' perpendicular to the axis A of guide 90. Lip 89 has a slightly concave surface (e.g.,

with a radius of curvature of 1 inch) and extends outwardly from guide 90 (e.g., by 0.5 mm). A portion of lip 89 may be removed to define a recess 91 having a curvature that approximates the contour of graft 87. Recess 91 enables lip 89 to be positioned more closely to previously inserted grafts 87 or other structures in area 80 (such as cartilage 4 surrounding exposed area 80).

[0052] Referring to Figs. 11a-11c, the guide may include various spacers for positioning the guide in a lateral orientation with respect to previously inserted grafts 87 or other structures in area 80. Fig. 11a shows a spacer 92 that has a pin shape and is located along a side of the guide. Spacer 92 may be retractable, or not.

[0053] The spacer may have other configurations. For example, spacer 94 (Fig. 11b) has a tooth shape. Spacer 96 (Fig. 11c) is in the form of an enlarged rim portion and provides the spacing by being engaged against the side of a previously inserted graft 87 or, alternatively, by being aligned with the side of an adjacent hole 88.

[0054] As shown in Figs. 12a and 12b, another embodiment of a retractable spacer includes a sleeve 98 with a projecting pin 98a inserted over guide 12. Pin 98a enters a previously-formed graft receiving hole 88 to position guide passage 19 a selected distance therefrom. This feature helps provide sufficient bone wall thickness between adjacent holes 88.

[0055] Referring to Figs. 13a and 13b, guide 100 includes a hypodermic needle 102 within which a set of retractable wire prongs 104 are disposed. The distal end of each prong 104 is resiliently biased outwardly so that when prongs 104 are extended the tips of prongs 104 define a plane **P** oriented perpendicular to needle 102. The proximal ends of prongs 104 are connected to a handle 105, which is slid within needle 102 to selectively retract and extend prongs 104. Guide 100 is used, for example, to approximate the perpendicular approach to the bone before making an incision in the tissue. Thus, guide 100 may be used to determine the entry location for guide 12.

[0056] As shown in Figs. 14a and 14b, after needle 102 is inserted into the patient's body, prongs 104 are extended from the tip of needle 102. If one or more prongs 104 do not engage the bone surface, then prongs 104 are retracted into needle 102, and needle 102 is withdrawn from the patient's body. Needle 102 is then reinserted into the patient's body in another area to locate perpendicularity with respect to the bone surface. If all prongs 104 engage the bone surface, needle 102 is perpendicular to the bone surface.

[0057] In other embodiments, guide 12 may have a one-way valve 93 (shown schematically in Fig. 10a) located near proximal end 18 to block fluid flow through passage 19 from window 19a when an instrument is inserted in (and removed from) guide 12. Alternatively, window 19a may be formed of clear plastic and thus, closed to passage 19. In still other embodiments, tube 13 may be made from clear plastic, thereby obviating the need for window 19a.

[0058] The length of rod 60 may be adjusted in other ways, such as by simply sliding rod 60 axially toward and away from handle 70. Insertion tool 50 may be made partially or wholly from plastic. A button of plastic or a soft material may be attached to distal tip 64 to protect the cartilage on the upper surface of graft 87 from damaged during insertion. With respect to drill 40 or dilator 47, a stop may be provided at its proximal end to engage guide proximal end 15b and limit the extent to which drill 40 or dilator 47 can be advanced into the bone. The stop may be adjustable, or not.

[0059] There has been described novel and improved apparatus and methods for replacing damaged or defective cartilage with grafts harvested from elsewhere in the body. Although the invention has been describe in inserting the grafts into pre-drilled holes in the femur, the invention may be used with other tissue surfaces and in other areas of the body, such as the ankle, hip, and shoulder. It is evident that those skilled in the art may now make numerous uses and modifications of and departures from the specific embodiments described herein without departing from the inventive concept.

Claims

1. Apparatus for use with a surgical instrument, such as a drill or an insertion tool during a procedure in which a tissue graft is inserted into bone tissue, said apparatus comprising :

   a guide (12) configured to orient the surgical instrument perpendicularly to a surface of the bone tissue, said guide (12) including a tubular guiding portion (13) disposed along a longitudinal axis for engaging the surgical instrument and a tissue-engaging portion (14) oriented perpendicularly to said longitudinal axis at a distal end (17) of the tubular guiding portion (13) **characterised in that** the tissue engaging portion (14) comprises a step-like decrease in diameter of the tubular guiding portion (13) to form a rim (14a) the tubular guiding portion of reduced diameter defining a flange (16) projecting distally from the rim (14a).

2. The apparatus of claim 1 further comprising said surgical instrument, which is a drill (40) for drilling a hole (88) in the bone tissue surface for receiving the tissue graft, said tubular guiding portion (13) being sized to receive and align said drill (40) perpendicularly to the bone surface.

3. The apparatus of claim 2 wherein said drill (40) includes a distal end that comprises a pointed distal tip (43a) and a plurality of cutting flutes circumferentially spaced around said distal end (44) proximally adjacent to said tip.

4. The apparatus of claim 2 or claim 3 wherein said drill (40) includes markings (41a), (41b) to indicate a depth of the hole (88).

5. The apparatus of any one of claims 2 to 4 further comprising a dilator (47) having a distal end (49b) sized to enlarge the hole(81), said tubular guiding portion (13) being sized to receive and align said dilator (47) perpendicularly to the bone surface.

6. The apparatus of claim 5 wherein said distal end (49b) of said dilator (47) is tapered.

7. The apparatus of claim 5 or claim 6 wherein said dilator (47) includes markings (46a, 46b) to indicate a depth that said distal end (49b) is inserted in the hole.

8. The apparatus of claim 1 further comprising said surgical instrument, which is an insertion tool (50) for inserting the tissue graft into a hole in the bone, said tubular guiding portion (13) being sized to receive and align a portion of said insertion tool (50) perpendicularly to the bone surface.

9. The apparatus of claim 8 wherein said portion of said insertion tool (50) has a length that is adjustable relative to a length of said guide (12) to allow corresponding adjustment of an amount by which the graft protrudes from the hole.

10. The apparatus of claim 9 wherein said portion of said insertion tool (50) includes a rod (60) attached to a handle (70) that is configured to engage a proximal end (18) of said guide (12), said rod (60) having an adjustable length relative to said handle (70).

11. The apparatus of claim 10 wherein said rod (60) has a distal end (64) configured to engage the graft and a proximal end (62) that is progressively insertable into an opening in said handle (70) to adjust the length of said rod (60) relative to said handle (70).

12. The apparatus of claim 11 wherein said proximal end of said rod (60) is threadably received within said opening to allow adjustment of said length by relative rotation between said handle (70) and said rod (60).

13. The apparatus of of claim 11 or claim 12 further comprising a resilient member (76) disposed in said opening in engagement with said proximal end (62) of said rod (60) for maintaining said rod (60) in position at the adjusted length.

14. The apparatus of any one of claims 10 to 13 wherein said rod (60) includes markings (69) to indicate the amount by which the graft protrudes from the hole.

15. The apparatus of anyone of the preceding claims that further comprises a spacer (92,94,96,98,98a) for positioning said tubular guiding portion (13) at a selected location relative to a feature on bone tissue.

16. The apparatus of claim 15 wherein the feature is a hole (88) in the bone tissue and said spacer includes a member (92,94,96,98a) that projects distally relative to said tissue-engaging portion (14) of said guide (12) for insertion into the hole (88).

17. The apparatus of claim 16 wherein said member is retractable (92, 98a) with respect to said tissue-engaging portion (14) of said guide (12).

18. The apparatus of claim 16 or claim 17 wherein said member includes a pin (92).

19. The apparatus of claim 16 or claim 17 wherein said member includes a tooth (94,96).

20. The apparatus of any one of claims 16 to 19 wherein said member is disposed on a sleeve (98) that is receivable over said guide (12).

21. The apparatus of claim 15 wherein the feature includes a region of cartilage on the bone tissue, said spacer including an enlarged lip (96) disposed adjacent to said tissue-engaging portion (14) of said guide (12) for engaging the region of cartilage.

22. The apparatus of any one of the preceding claims wherein said guide includes a window (19a) for allowing viewing within the tubular guiding portion.

23. The apparatus of claim 22 wherein said guide (12) includes a valve (93) for blocking fluid flow through the tubular guiding portion (13).

24. The apparatus of anyone of the preceding claims wherein a portion of said guide comprises clear material.

25. A set of instruments for use during a procedure in which a tissue graft that includes bone having a layer of cartilage thereon is inserted into bone tissue, comprising

a guide (12) configured to orient another instrument in said set perpendicularly to a surface of the bone tissue, said guide (12) including a tubular guiding portion (13) disposed along a longitudinal axis for engaging the surgical instrument and a tissue-engaging portion (14) oriented perpendicularly to said longitudinal axis, at a distal end (17) of the tubular guiding portion (13) **characterized in that** the tissue engaging portion (14) comprises a step-like decrease in diameter of the tubular guiding por-

tion (13) to form a rim (14a), the tubular guiding portion of reduced diameter defining a flange (16) projecting distally from the rim (14a),

a drill engageable with said tubular guiding portion for drilling a hole (88) in the bone tissue surface for receiving the tissue graft, and

an insertion tool (50) engageable with said tubular guiding portion (13) for inserting the tissue graft into the hole (88) formed by said drill (40).

26. The set of instruments of claim 25 wherein said insertion tool (50) includes a portion having a length that is adjustable relative to a length of said guide (12) to allow corresponding adjustment of an amount by which the graft protrudes from the hole.

27. The set of instruments of claim 25 or claim 26 further comprising a dilator (47) engageable with said guiding portion (12) and having a distal end (49b) sized to enlarge the hole formed by said drill (40) prior to insertion of the tissue graft.

28. The set of instruments of any one of claims 25 to 27 further comprising a tool (32) for removing the tissue graft from a bone.

29. The set of instruments of claim 28 wherein said tool includes

a chisel (20) having a hollow shaft (21) that extends distally from a handle (28) and terminates in a sharpened, hollow tip (22) configured to capture the tissue graft therein, said handle (28) having a passage therein that communicates with said hollow shaft (21),

a collar (30) that is slidable over said shaft (21) to shield said hollow tip (22) during removal of the tissue graft therefrom, and

a member (32) insertable into said hollow tip to engage the tissue graft and remove the tissue graft proximally through said shaft (21) and said passage of said handle (28).

30. The set of instruments of claim 29 wherein said collar (30) includes a flared opening disposed adjacent to said tip (22) when said collar (30) is inserted over said shaft (21).

31. The set of instruments of any one of claims 25 to 30 further comprising a template (85) for measuring a size of the tissue graft.

32. The set of instruments of any one of claims 25 to 31 further comprising a device for determining an entry portal for said guide over the bone surface, said device comprising

a needle (102) disposed along a longitudinal axis and having an open distal end, and

a plurality of prongs (104) disposed within said needle and having resiliently curved distal tips, said prongs being slidable within said needle (102) between a retracted position in which said distal tips are disposed within said needle and an extended position in which said distal tips project from said needle to engage the bone surface and define a plane that is perpendicular to said longitudinal axis.

33. The set of instruments of any one of claims 25 to 32 sized to insert a tissue graft having a selected size, and further comprising at least one other set of said instruments sized to insert a tissue graft having a different selected size.

Patentansprüche

1. Eine Vorrichtung zur Verwendung mit einem chirurgischen Instrument, wie etwa einem Bohrer oder einem Einführungswerkzeug, während eines Verfahrens, bei dem ein Gewebetransplantat in Kochengewebe eingeführt wird, wobei die Vorrichtung Folgendes beinhaltet:

eine Führung (12), die konfiguriert ist, um das chirurgische Instrument senkrecht zu einer Oberfläche des Knochengewebes zu orientieren, wobei die Führung (12) einen röhrenförmigen Führungsabschnitt (13), der entlang einer Längsachse zum Eingreifen in das chirurgische Instrument angeordnet ist, und einen in das Gewebe eingreifenden Abschnitt (14), der senkrecht zur Längsachse an einem distalen Ende (17) des röhrenförmigen Führungsabschnitts (13) orientiert ist, umfasst, **dadurch gekennzeichnet, dass** der in das Gewebe eingreifende Abschnitt (14) eine stufenartige Verringerung im Durchmesser des röhrenförmigen Führungsabschnitts (13) beinhaltet, um einen Rand (14a) zu bilden, wobei der röhrenförmige Führungsabschnitt von reduziertem Durchmesser einen Flansch (16) definiert, der distal vom Rand (14a) vorsteht.

2. Vorrichtung gemäß Anspruch 1, die ferner das chirurgische Instrument beinhaltet, das ein Bohrer (40) zum Bohren eines Lochs (88) in die Knochengewebsoberfläche zum Aufnehmen des Gewebetransplantats ist, wobei der röhrenförmige Führungsabschnitt (13) bemessen ist, um den Bohrer (40) aufzunehmen und senkrecht zur Knochenoberfläche auszurichten.

3. Vorrichtung gemäß Anspruch 2, wobei der Bohrer (40) ein distales Ende umfasst, das eine spitz zulaufende distale Spitze (43a) und eine Vielzahl von Schneiderillen beinhaltet, die im Umfang mit Abstand um das distale Ende (44) proximal an die Spit-

ze anliegend angeordnet sind.

4. Vorrichtung gemäß Anspruch 2 oder Anspruch 3, wobei der Bohrer (40) Markierungen (41a), (41b) umfasst, um eine Tiefe des Lochs (88) anzuzeigen.

5. Vorrichtung gemäß einem der Ansprüche 2 bis 4, die einen Dilatator (47) mit einem distalen Ende (49b) beinhaltet, der bemessen ist, um das Loch (81) zu vergrößern, wobei der röhrenförmige Führungsabschnitt (13) bemessen ist, um den Dilatator (47) aufzunehmen und senkrecht zur Knochenoberfläche auszurichten.

6. Vorrichtung gemäß Anspruch 5, wobei das distale Ende (49b) des Dilatators (47) verjüngt ist.

7. Vorrichtung gemäß Anspruch 5 oder Anspruch 6, wobei der Dilatator (47) Markierungen (46a, 46b) umfasst, um anzuzeigen, wie tief das distale Ende (49b) in das Loch eingeführt wird.

8. Vorrichtung gemäß Anspruch 1, die ferner das chirurgische Instrument beinhaltet, das ein Einführungswerkzeug (50) zum Einführen des Gewebetransplantats in ein Loch im Knochen ist, wobei der röhrenförmige Führungsabschnitt (13) bemessen ist, um einen Abschnitt des Einführungswerkzeugs (50) aufzunehmen und senkrecht zur Knochenoberfläche auszurichten.

9. Vorrichtung gemäß Anspruch 8, wobei der Abschnitt des Einführungswerkzeugs (50) eine Länge aufweist, die relativ zu einer Länge der Führung (12) einstellbar ist, um ein entsprechendes Einstellen eines Betrags, um den das Transplantat von dem Loch vorsteht, zu ermöglichen.

10. Vorrichtung gemäß Anspruch 9, wobei der Abschnitt des Einführungswerkzeugs (50) eine an einem Drehknopf (70) befestigte Stange (60) umfasst, die konfiguriert ist, um in ein proximales Ende (18) der Führung (12) einzugreifen, wobei die Stange (60) eine relativ zum Drehknopf (70) einstellbare Länge aufweist.

11. Vorrichtung gemäß Anspruch 10, wobei die Stange (60) ein distales Ende (64) aufweist, das konfiguriert ist, um in das Transplantat und ein proximales Ende (62), das schrittweise in eine Öffnung in dem Drehknopf (70) eingeführt werden kann, einzugreifen, um die Länge der Stange (60) relativ zum Drehknopf (70) einzustellen.

12. Vorrichtung gemäß Anspruch 11, wobei das proximale Ende der Stange (60) gewindeartig innerhalb der Öffnung aufgenommen wird, um das Einstellen der Länge durch relatives Drehen zwischen dem Drehknopf (70) und der Stange (60) zu ermöglichen.

13. Vorrichtung gemäß Aspruch 11 oder Anspruch 12, die ferner ein elastisches Teil (76) aufweist, das in der Öffnung in Eingriff mit dem proximalen Ende (62) der Stange (60) zum Halten der Stange (60) in der Position an der eingestellten Länge angeordnet ist.

14. Vorrichtung gemäß einem der Ansprüche 10 bis 13, wobei die Stange (60) Markierungen (69) umfasst, um den Betrag, um den das Transplantat von dem Loch vorsteht, anzuzeigen.

15. Vorrichtung gemäß einem der vorhergehenden Ansprüche, die ferner einen Abstandshalter (92, 94, 96, 98, 98a) zum Positionieren des röhrenförmigen Führungsabschnitts (13) an einer ausgewählten Stelle relativ zu einem Merkmal auf dem Knochengewebe umfasst.

16. Vorrichtung gemäß Anspruch 15, wobei das Merkmal ein Loch (88) im Knochengewebe ist und der Abstandshalter ein Teil (92, 94, 96, 98a) umfasst, das distal relativ zum in das Gewebe eingreifenden Abschnitt (14) der Führung (12) zum Einführen in das Loch (88) vorsteht.

17. Vorrichtung gemäß Anspruch 16, wobei das Teil mit Bezug auf den in das Gewebe eingreifenden Abschnitt (14) der Führung (12) einziehbar (92, 98a) ist.

18. Vorrichtung gemäß Anspruch 16 oder Anspruch 17, wobei das Teil einen Stift (92) umfasst.

19. Vorrichtung gemäß Anspruch 16 oder Anspruch 17, wobei das Teil einen Zahn (94, 96) umfasst.

20. Vorrichtung gemäß einem der Ansprüche 16 bis 19, wobei das Teil auf einer Muffe (98), die über der Führung (12) aufnehmbar ist, angeordnet ist.

21. Vorrichtung gemäß Anspruch 15, wobei das Merkmal einen Knorpelgewebsbereich auf dem Knochengewebe umfasst, wobei der eine vergrößerte Lippe (96) umfassende Abstandshalter anliegend an den in das Gewebe eingreifenden Abschnitt (14) der Führung (12) zum Eingreifen in den Knorpelgewebsabschnitt angeordnet ist.

22. Vorrichtung gemäß einem der vorhergehenden Ansprüche, wobei die Führung ein Fenster (19a) umfasst, um das Sehen innerhalb des röhrenförmigen Führungsabschnitts zu ermöglichen.

23. Vorrichtung gemäß Anspruch 22, wobei die Füh-

rung (12) ein Ventil (93) zum Blockieren des Fluidflusses durch den röhrenförmigen Führungsabschnitt (13) umfasst.

24. Vorrichtung gemäß einem der vorhergehenden Ansprüche, wobei ein Abschnitt der Führung ein klares Material beinhaltet.

25. Ein Instrumentensatz zur Verwendung während eines Verfahrens, bei dem ein Gewebetransplantat, das Knochen mit einer Knorpelgewebsschicht darauf umfasst, in Knochengewebe eingeführt wird, der Folgendes beinhaltet:

eine Führung (12), die konfiguriert ist, um ein anderes Instrument in diesem Satz senkrecht zu einer Oberfläche des Knochengewebes zu orientieren, wobei die Führung (12) einen röhrenförmigen Führungsabschnitt (13), der entlang einer Längsachse zum Eingreifen in das chirurgische Instrument angeordnet ist, und einen in das Gewebe eingreifenden Abschnitt (14), der senkrecht zur Längsachse an einem distalen Ende (17) des röhrenförmigen Führungsabschnitts (13) orientiert ist, umfasst, **dadurch gekennzeichnet, dass** der in das Gewebe eingreifende Abschnitt (14) eine stufenweise Verringerung im Durchmesser des röhrenförmigen Führungsabschnitts (13) beinhaltet, um einen Rand (14a) zu bilden, wobei der röhrenförmige Führungsabschnitt von reduziertem Durchmesser einen Flansch (16) definiert, der distal vom Rand (14a) vorsteht,

einen Bohrer, der zum Bohren eines Lochs (88) in die Knochengewebsoberfläche in den röhrenförmigen Führungsabschnitt eingreifen kann, um ein Gewebetransplantat aufzunehmen, und

ein Einführungswerkzeug (50), das zum Einführen des Gewebetransplantats in das von dem Bohrer (40) gebildete Loch (88) in den röhrenförmigen Führungsabschnitt (13) eingreifen kann.

26. Instrumentensatz gemäß Anspruch 25, wobei das Einführungswerkzeug (50) einen Abschnitt mit einer Länge umfasst, die relativ zu einer Länge der Führung (12) einstellbar ist, um ein entsprechendes Einstellen eines Betrags, um den das Transplantat von dem Loch vorsteht, zu ermöglichen.

27. Instrumentensatz gemäß Anspruch 25 oder Anspruch 26, der ferner einen Dilatator (47) beinhaltet, der in den Führungsabschnitt (12) eingreifen kann, und ein distales Ende (49b) aufweist, das so bemessen ist, das es das durch den Bohrer (40) gebildete Loch vor dem Einführen des Gewebetransplantats vergrößert.

28. Instrumentensatz gemäß einem der Ansprüche 25 und 27, der ferner ein Werkzeug (32) zum Entfernen des Gewebetransplantats von einem Knochen beinhaltet.

29. Instrumentensatz gemäß Anspruch 28, wobei das Werkzeug Folgendes umfasst:

einen Meißel (20) mit einer hohlen Welle (21), die sich distal von einem Drehknopf (28) erstreckt und in einer geschärften, hohlen Spitze (22) mündet, die konfiguriert ist, um das Gewebetransplantat darin zu empfangen, wobei der Drehkopf (28) einen Gang darin aufweist, der mit der hohlen Welle (21) in Verbindung steht,

eine Einfassung (30), die über die Welle (21) gleiten kann, um die hohle Spitze (22) während der Entfernung des Gewebetransplantats davon abzuschirmen, und

ein Teil (32), das in die hohle Spitze einführbar ist, um in das Gewebetransplantat einzugreifen und das Gewebetransplantat proximal durch die Welle (21) und den Gang des Drehknopfs (28) zu entfernen.

30. Instrumentensatz gemäß Anspruch 29, wobei die Einfassung (30) eine konisch erweiterte Öffnung umfasst, die anliegend an die Spitze (22) angeordnet ist, wenn die Einfassung (30) über die Welle (21) eingeführt wird.

31. Instrumentensatz gemäß einem der Ansprüche 25 bis 30, der ferner eine Schablone (85) zum Messen einer Größe des Gewebetransplantats beinhaltet.

32. Instrumentensatz gemäß einem der Ansprüche 25 bis 31, der ferner eine Einrichtung zum Bestimmen eines Eingangs für die Führung über die Knochenoberfläche beinhaltet, wobei die Einrichtung Folgendes beinhaltet:

eine Nadel (102), die entlang einer Längsachse angeordnet ist und ein offenes distales Ende aufweist, und

eine Vielzahl von Zinken (104), die innerhalb der Nadel angeordnet sind und elastisch gebogene distale Spitzen aufweisen, wobei die Zinken innerhalb der Nadel (102) zwischen einer eingezogenen Position, in der die distalen Spitzen innerhalb der Nadel angeordnet sind, und einer ausgedehnten Position, in der die distalen Spitzen von der Nadel vorstehen, um in die

Knochenoberfläche einzugreifen und eine Ebene zu definieren, die senkrecht zur Längsachse ist, gleiten können.

33. Instrumentensatz gemäß einem der Ansprüche 25 bis 32, der bemessen ist, um ein Gewebetransplantat einer ausgewählten Größe einzuführen und der ferner mindestens einen anderen Satz der Instrumente, die zum Einführen eines Gewebetransplantats einer anderen ausgewählten Größe bemessen sind, beinhaltet.

Revendications

1. Appareil destiné à être utilisé avec un instrument chirurgical tel qu'une perceuse ou un outil d'insertion durant une procédure dans laquelle une greffe tissulaire est insérée dans du tissu osseux, ledit appareil comportant :

   un guide (12) configuré pour orienter l'instrument chirurgical perpendiculairement à une surface du tissu osseux, ledit guide (12) comprenant une portion de guidage tubulaire (13) disposée le long d'un axe longitudinal pour engager l'instrument chirurgical et une portion d'engagement de tissu (14) orientée perpendiculairement audit axe longitudinal à une extrémité distale (17) de la portion de guidage tubulaire (13) **caractérisé en ce que** la portion d'engagement de tissu (14) comporte un décroissement en échelon en diamètre de la portion de guidage tubulaire (13) pour former un bord (14a), la portion de guidage tubulaire de diamètre réduit définissant un flasque (16) se projetant de façon distale depuis le bord (14a).

2. L'appareil de la revendication 1 comportant de plus ledit instrument chirurgical, lequel est une perceuse (40) pour percer un trou (88) dans la surface de tissu osseux pour recevoir la greffe tissulaire, ladite portion de guidage tubulaire (13) étant dimensionnée pour recevoir et aligner ladite perceuse (40) perpendiculairement à la surface de l'os.

3. L'appareil de la revendication 2 dans lequel ladite perceuse (40) comprend une extrémité distale qui comporte un bout distal pointu (43a) et une pluralité de cannelures de coupe espacées de façon circonférentielle autour de ladite extrémité distale (44) adjacente de façon proximale audit bout.

4. L'appareil de la revendication 2 pu la revendication 3 dans lequel ladite perceuse (40) comprend des repères (41a), (41b) pour indiquer une profondeur du trou (88).

5. L'appareil de n'importe laquelle des revendications 2 à 4 comportant de plus un dilatateur (47) ayant une extrémité distale (49b) dimensionnée pour agrandir le trou (81), ladite portion de guidage tubulaire (13) étant dimensionnée pour recevoir et aligner ledit dilatateur (47) perpendiculairement à la surface de l'os.

6. L'appareil de la revendication 5 dans lequel ladite extrémité distale (49b) dudit dilatateur (47) est effilée.

7. L'appareil de la revendication 5 ou la revendication 6 dans lequel ledit dilatateur (47) comprend des repères (46a, 46b) pour indiquer une profondeur à laquelle ladite extrémité distale (49b) est insérée dans le trou.

8. L'appareil de la revendication 1 comportant de plus ledit instrument chirurgical, lequel est un outil d'insertion (50) pour insérer la greffe tissulaire dans un trou dans l'os, ladite portion de guidage tubulaire (13) étant dimensionnée pour recevoir et aligner une portion dudit outil d'insertion (50) perpendiculairement à la surface de l'os.

9. L'appareil de la revendication 8 dans lequel ladite portion dudit outil d'insertion (50) a une longueur qui est réglable relativement à une longueur dudit guide (12) pour permettre le réglage correspondant d'une étendue de laquelle la greffe dépasse du trou.

10. L'appareil de la revendication 9 dans lequel ladite portion dudit outil d'insertion (50) comprend une tige (60) attachée à une poignée (70) qui est configurée pour engager une extrémité proximale (18) dudit guide (12), ladite tige (60) ayant une longueur réglable relativement à ladite poignée (70).

11. L'appareil de la revendication 10 dans lequel ladite tige (60) a une extrémité distale (64) configurée pour engager la greffe et une extrémité proximale (62) qui peut être progressivement insérée dans une ouverture dans ladite poignée (70) pour régler la longueur de ladite tige (60) relativement à ladite poignée (70).

12. L'appareil de la revendication 11 dans lequel ladite extrémité proximale de ladite tige (60) est reçue de façon enfilable au sein de ladite ouverture pour permettre le réglage de ladite longueur grâce à la rotation relative entre ladite poignée (70) et ladite tige (60).

13. L'appareil de la revendication 11 ou la revendication 12 comportant de plus un élément élastique (76) disposé dans ladite ouverture en engagement avec ladite extrémité proximale (62) de ladite tige (60)

pour maintenir ladite tige (60) en position à la longueur réglée.

14. L'appareil de n'importe laquelle des revendications 10 à 13 dans lequel ladite tige (60) comprend des repères (69) pour indiquer l'étendue de laquelle la greffe dépasse du trou.

15. L'appareil de n'importe laquelle des revendications précédentes qui comporte de plus une pièce d'espacement (92, 94, 96, 98, 98a) pour positionner ladite portion de guidage tubulaire (13) à un emplacement sélectionné relativement à une caractéristique sur du tissu osseux.

16. L'appareil de la revendication 15 dans lequel la caractéristique est un trou (88) dans le tissu osseux et ladite pièce d'espacement comprend un élément (92, 94, 96, 98a) qui se projette de façon distale relativement à ladite portion d'engagement de tissu (14) dudit guide (12) pour être inséré dans le trou (88).

17. L'appareil de la revendication 16 dans lequel ledit élément est rétractable (92, 98a) par rapport à ladite portion d'engagement de tissu (14) dudit guide (12).

18. L'appareil de la revendication 16 ou la revendication 17 dans lequel ledit élément comprend une broche (92).

19. L'appareil de la revendication 16 ou la revendication 17 dans lequel ledit élément comprend une dent (94, 96).

20. L'appareil de n'importe laquelle des revendications 16 à 19 dans lequel ledit élément est disposé sur un manchon (98) qui peut être reçu par-dessus ledit guide (12).

21. L'appareil de la revendication 15 dans lequel la caractéristique comprend une zone de cartilage sur le tissu osseux, ladite pièce d'espacement comprenant une lèvre agrandie (96) disposée de façon adjacente à ladite portion d'engagement de tissu (14) dudit guide (12) pour engager la zone de cartilage.

22. L'appareil de n'importe laquelle des revendications précédentes dans lequel ledit guide comprend une fenêtre (19a) pour permettre de voir au sein de la portion de guidage tubulaire.

23. L'appareil de la revendication 22 dans lequel ledit guide (12) comprend une valve (93) pour bloquer un écoulement de fluide au travers de la portion de guidage tubulaire (13).

24. L'appareil de n'importe laquelle des revendications précédentes dans lequel une portion dudit guide comporte du matériau transparent.

25. Un ensemble d'instruments destiné à être utilisé durant une procédure dans laquelle une greffe tissulaire qui comprend de l'os recouvert d'une couche de cartilage est insérée dans du tissu osseux, comportant
un guide (12) configuré pour orienter un autre instrument dans ledit ensemble perpendiculairement à une surface du tissu osseux, ledit guide (12) comprenant une portion de guidage tubulaire (13) disposée le long d'un axe longitudinal pour engager l'instrument chirurgical et une portion d'engagement de tissu (14) orientée perpendiculairement audit axe longitudinal, à une extrémité distale (17) de la portion de guidage tubulaire (13) **caractérisé en ce que** la portion d'engagement de tissu (14) comporte un décroissement en échelon en diamètre de la portion de guidage tubulaire (13) pour former un bord (14a), la portion de guidage tubulaire de diamètre réduit définissant un fiasque (16) se projetant de façon distale depuis le bord (14a),
une perceuse pouvant être engagée dans ladite portion de guidage tubulaire pour percer un trou (88) dans la surface de tissu osseux pour recevoir la greffe tissulaire, et
un outil d'insertion (50) pouvant être engagé dans ladite portion de guidage tubulaire (13) pour insérer la greffe tissulaire dans le trou (88) formé par ladite perceuse (40).

26. L'ensemble d'instruments de la revendication 25 dans lequel ledit outil d'insertion (50) comprend une portion ayant une longueur qui est réglable relativement à une longueur dudit guide (12) pour permettre le réglage correspondant d'une étendue de laquelle la greffe dépasse du trou.

27. L'ensemble d'instruments de la revendication 25 ou la revendication 26 comportant de plus un dilatateur (47) pouvant être engagé dans ladite portion de guidage (12) et ayant une extrémité distale (49b) dimensionnée pour agrandir le trou formé par ladite perceuse (40) avant l'insertion de la greffe tissulaire.

28. L'ensemble d'instruments de n'importe laquelle des revendications 25 à 27 comportant de plus un outil (32) pour enlever la greffe tissulaire d'un os.

29. L'ensemble d'instruments de la revendication 28 dans lequel ledit outil comprend
un ciseau (20) ayant un arbre creux (21) qui s'étend de façon distale depuis une poignée (28) et se termine en un bout creux aiguisé (22) configuré pour y capturer la greffe tissulaire, ladite poignée (28) ayant dans celle-ci un passage qui communique

avec ledit arbre creux (21),
un collier (30) qui peut coulisser par-dessus ledit arbre (21) pour protéger ledit bout creux (22) lorsque la greffe tissulaire est enlevée de celui-ci, et
un élément (32) pouvant être inséré dans ledit bout creux pour engager la greffe tissulaire et enlever la greffe tissulaire de façon proximale à travers ledit arbre (21) et ledit passage de ladite poignée (28).

30. L'ensemble d'instruments de la revendication 29 dans lequel ledit collier (30) comprend une ouverture évasée disposée de façon adjacente audit bout (22) lorsque ledit collier (30) est inséré par-dessus ledit arbre (21).

31. L'ensemble d'instruments de n'importe laquelle des revendications 25 à 30 comportant de plus un gabarit (85) pour mesurer une dimension de la greffe tissulaire.

32. L'ensemble d'instruments de n'importe laquelle des revendications 25 à 31 comportant de plus un dispositif pour déterminer une porte d'entrée pour ledit guide par-dessus la surface de l'os, ledit dispositif comportant
une aiguille (102) disposée le long d'un axe longitudinal et ayant une extrémité distale ouverte, et
une pluralité de fourchons (104) disposés au sein de ladite aiguille et ayant des bouts distaux incurvés de façon élastique, lesdits fourchons pouvant coulisser au sein de ladite aiguille (102) entre une position retirée dans laquelle lesdits bouts distaux sont disposés au sein de ladite aiguille et une position étendue dans laquelle lesdits bouts distaux se projettent depuis ladite aiguille pour engager la surface de l'os et définir un plan qui est perpendiculaire audit axe longitudinal.

33. L'ensemble d'instruments de n'importe laquelle des revendications 25 à 32 dimensionné pour insérer une greffe tissulaire ayant une dimension sélectionnée, et comportant de plus au moins un autre ensemble desdits instruments dimensionné pour insérer une greffe tissulaire ayant une dimension sélectionnée différente.

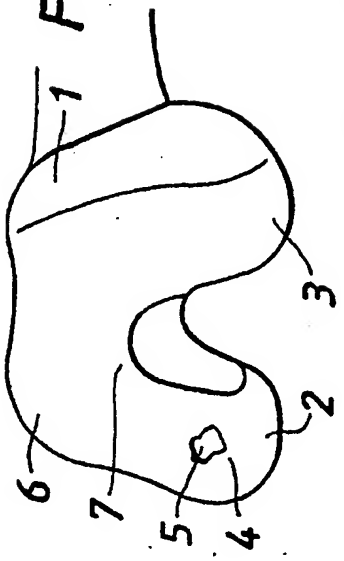


FIG.1.

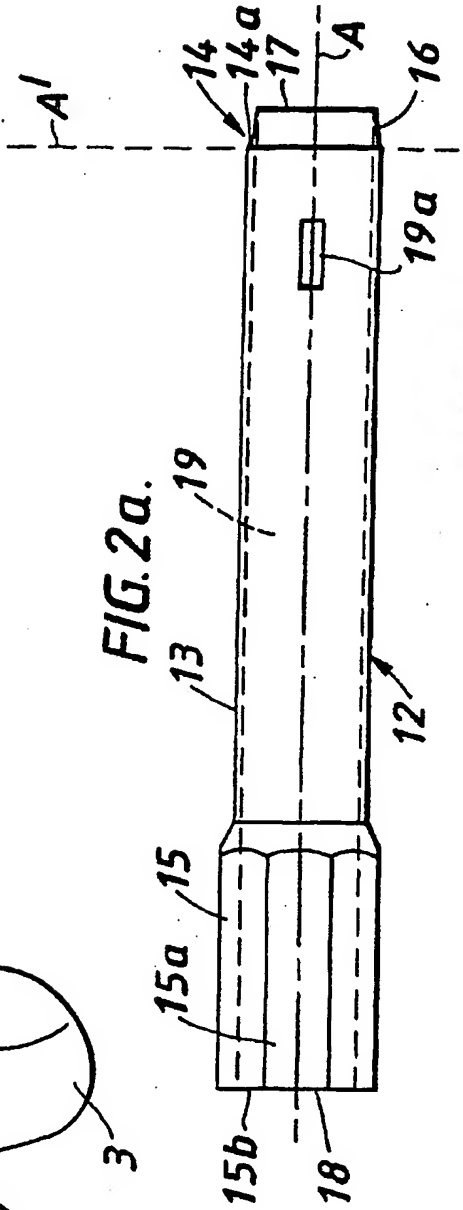


FIG.2a.

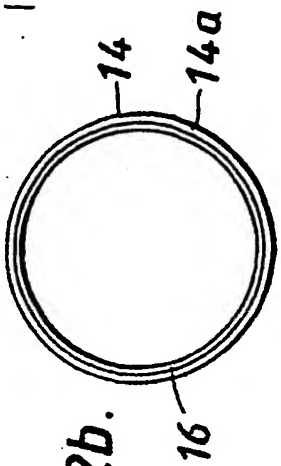


FIG.2b.

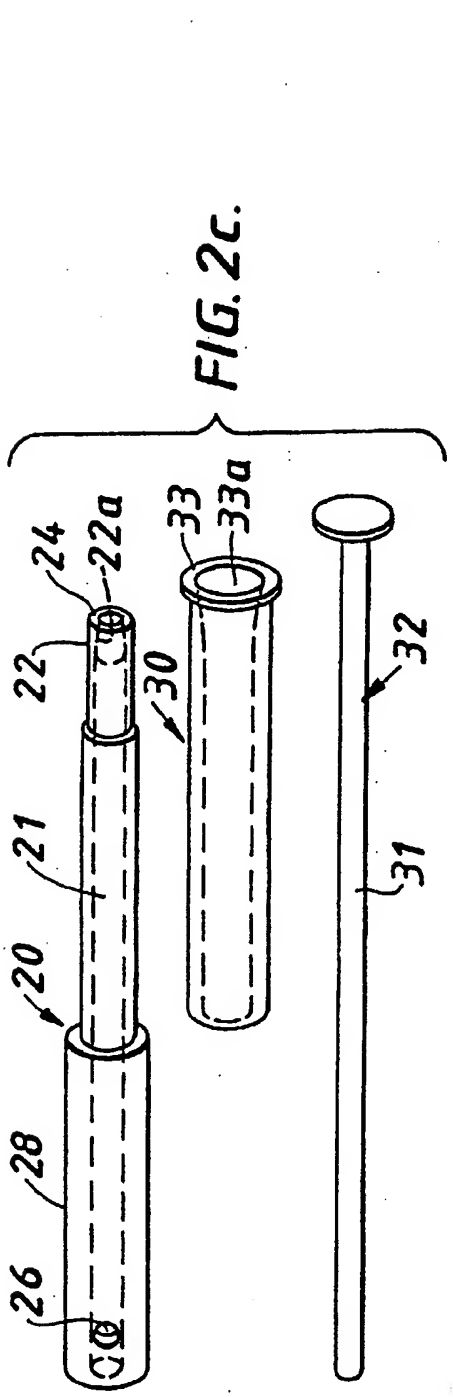


FIG. 2c.

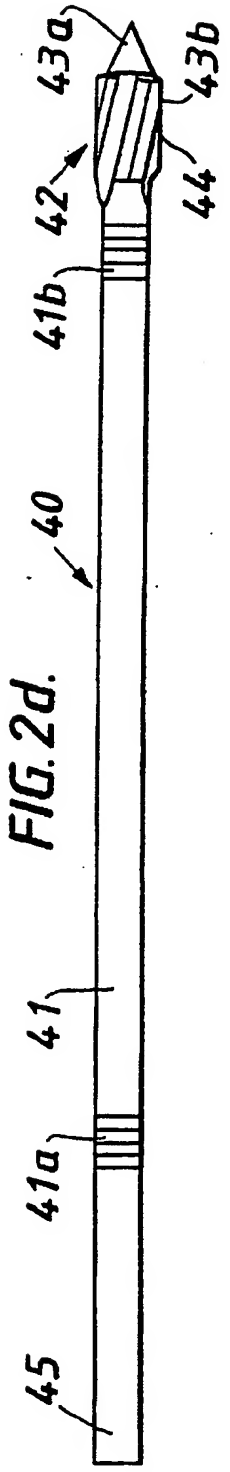


FIG. 2d.

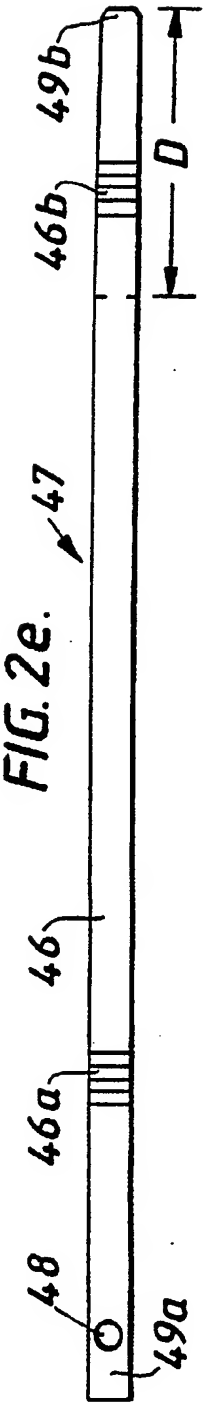


FIG. 2e.

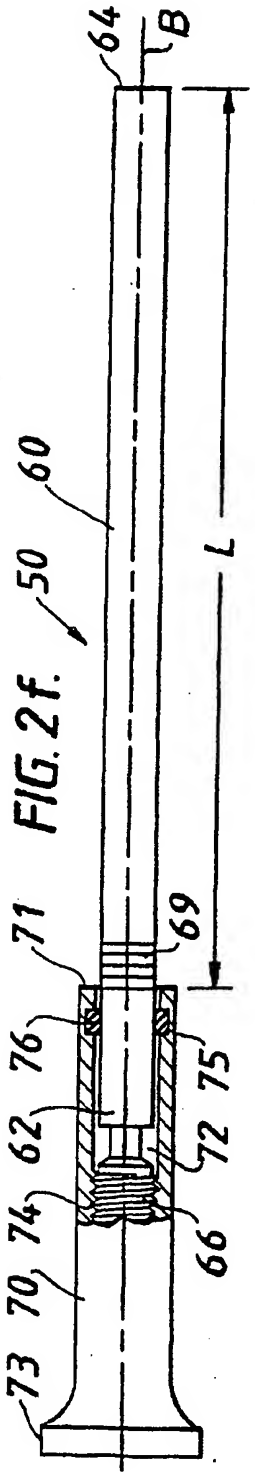


FIG. 2f.

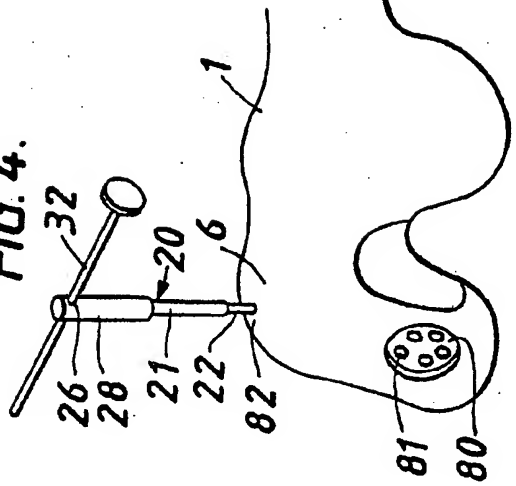


FIG. 4.

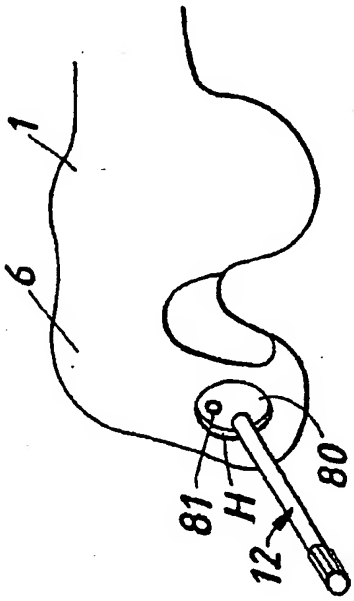


FIG. 3.

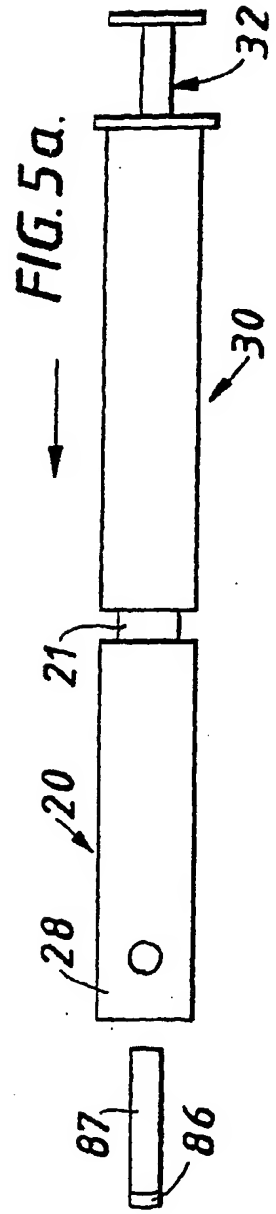


FIG. 5a.

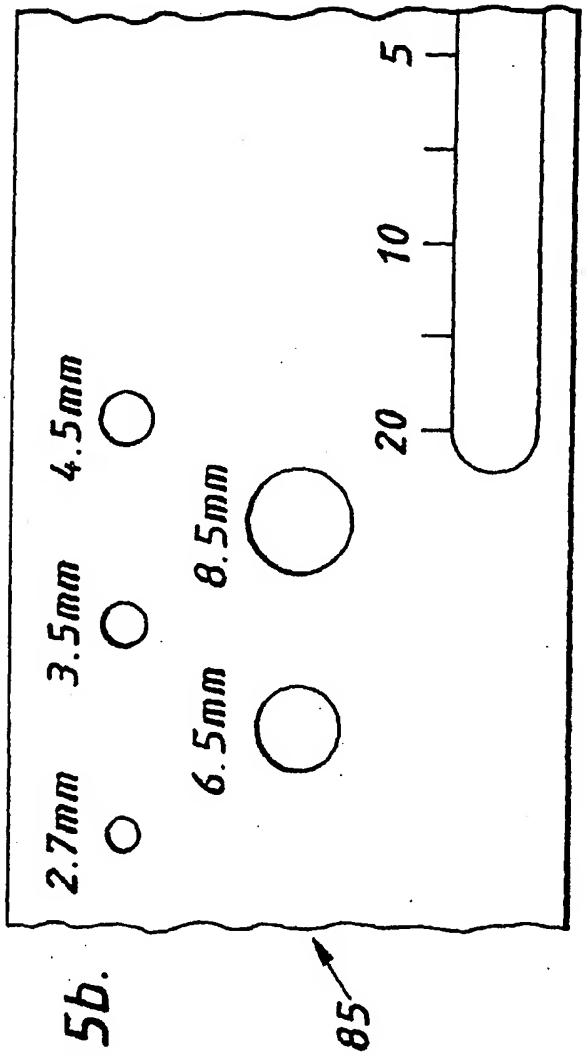


FIG. 5b.

FIG. 6.

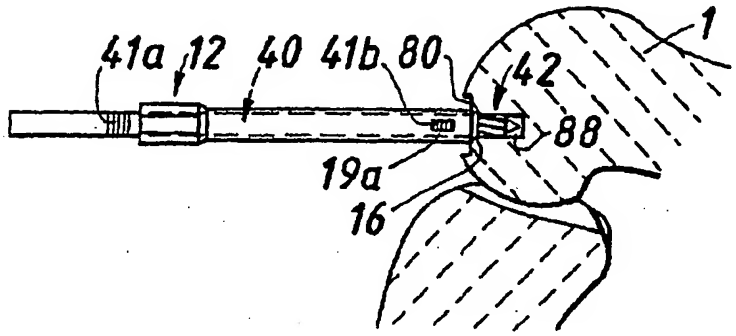


FIG. 7.

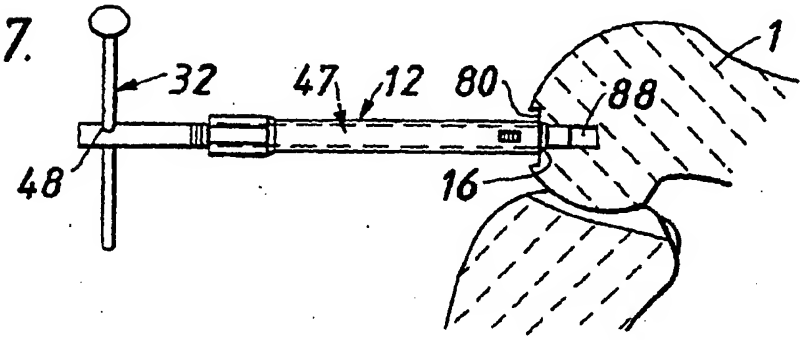


FIG. 8.

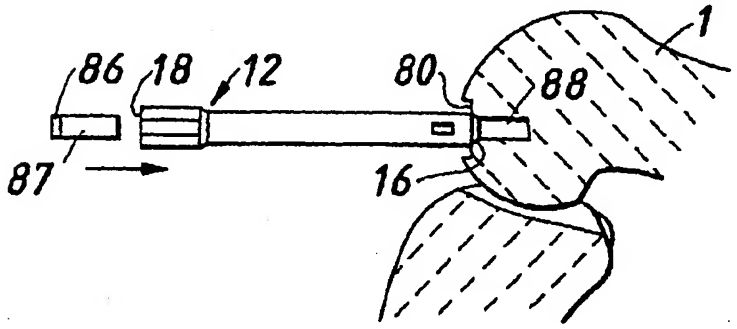


FIG. 9.

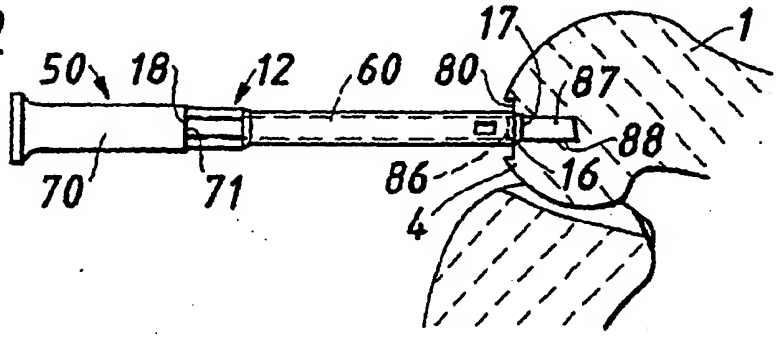


FIG.10a.

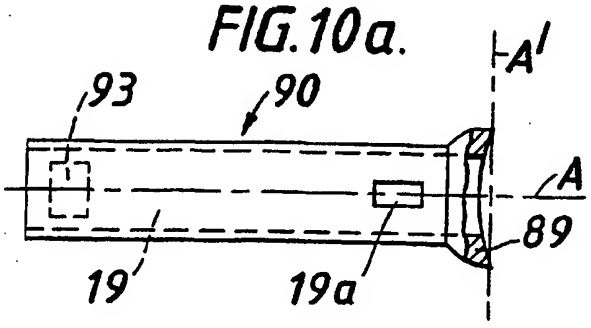
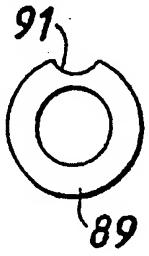


FIG.10b.



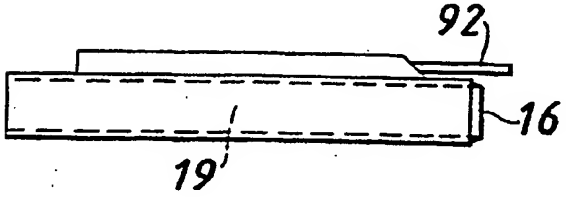


FIG.11a.

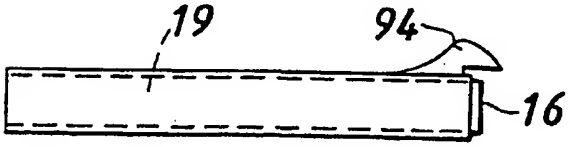


FIG.11b.

FIG.11c.

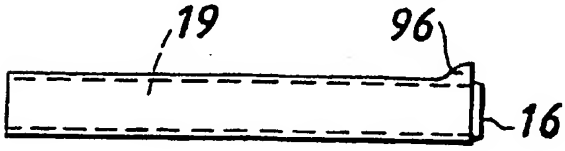


FIG. 12a.

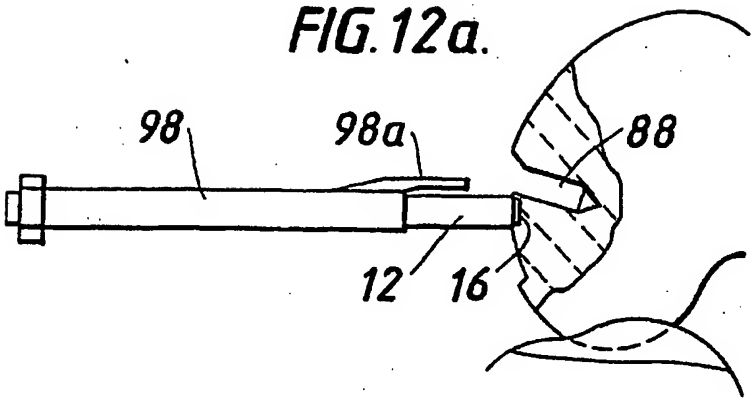
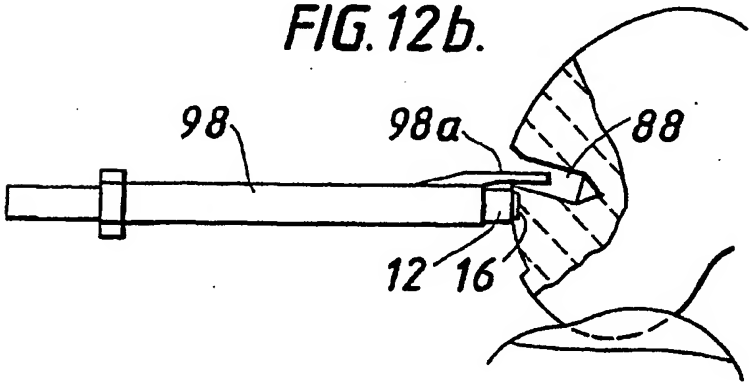


FIG. 12b.



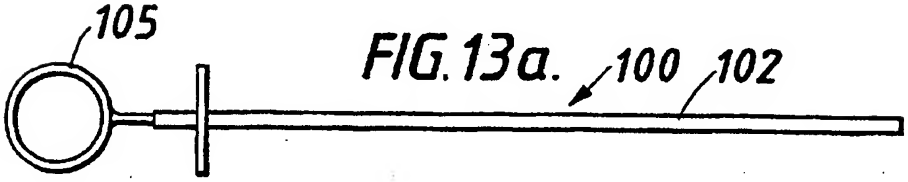


FIG. 13a.

FIG. 13b.

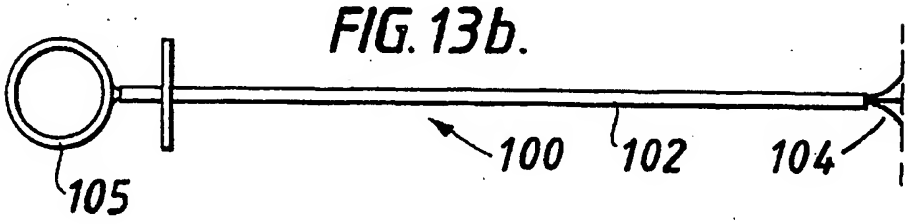


FIG. 14a.

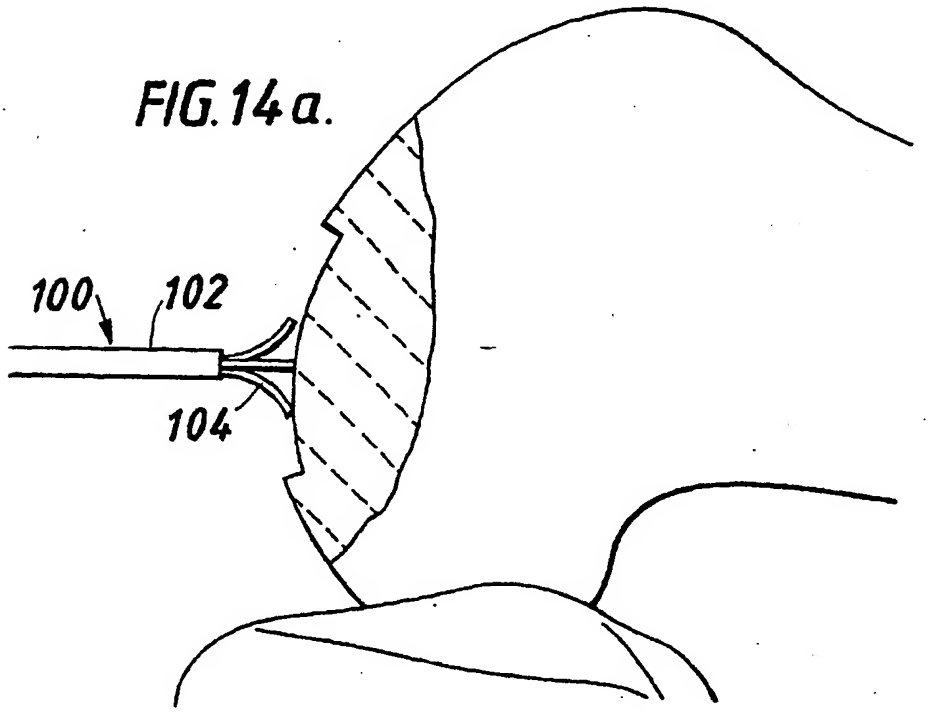


FIG. 14b.